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# A REVIEW OF MOUNTAIN PINE BEETLE MANAGEMENT IN THE NORTHERN REGION DURING THE DECADE 1982-1991

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## *Introduction*

During 1991, a Forest Pest Management Review Team from the Washington Office reviewed mountain pine beetle management activities in the Northern Region during the preceding decade. Moreover, they were assessing the expenditure of FPM suppression funds as a component of those activities. Questions arose concerning: How much money was requested, granted and spent during the period? What types of activities were supported by those funds? And finally, did the effects of those activities represent a judicious return on our investment? Further, the review team evaluated the need for additional funding as mountain pine beetle populations continued a decade-long decline.

We were asked to summarize our cumulative efforts, make some determination of their effect, and recommend future uses of FPM funds as they pertain to forest health in general and mountain pine beetle management, specifically.

## *Mountain Pine Beetle in the Northern Region*

The mountain pine beetle, *Dendroctonus ponderosae* Hopkins (MPB), is by far the most destructive insect pest of pine species in western North America. Although most pine species within its range will serve as host, and significant amounts of mortality have occurred in many of them, lodgepole pine is its preferred--and most devastated--host species. Populations of the beetle have existed in an "outbreak" condition in much of the

lodgepole pine type from northern Utah to the Okanagan Valley of British Columbia for most of the past 30 years. As a result, MPB has had a significant effect upon management philosophy, decisions, and activities throughout that period of time.

In the Northern Region, MPB epidemics have been reported with some regularity since the early decades of the 20th century. The current series of outbreaks are considered to have begun somewhat concurrently in large expanses of unmanaged stands of lodgepole pine in the extreme southwest and northwest parts of Montana. In the mid-1960's, an infestation developed in Yellowstone National Park (NP)--believed to have begun on the adjacent Targhee National Forest (NF). Within a few years, major outbreaks had developed on the Gallatin and Beaverhead NFs to the north and west. In the early 1970's, MPB epidemics were first observed within Glacier NP. Within a few years, additional ones were noted on the Flathead, Kootenai and Lolo NFs and adjacent lands of other ownerships (Gibson and Oakes 1989).

By 1978, major MPB outbreaks existed on the Beaverhead, Gallatin, Flathead, Lewis & Clark, Lolo, and Kootenai NFs, in Yellowstone and Glacier NPs, on several Indian Reservations in Montana, and on much intermingled State and private land. In total, nearly 820,000 acres were infested. Extensive ground surveys in 1979 showed an estimated 33.4 million trees had been killed, to that date, on slightly less than 986,000 acres (Bennett, et al., 1980). Total infested area continued to increase until 1981 when peak level of the outbreaks was reached at almost 2.5 million acres. (Note: To avoid confusion, we point out that in 1981, those 2.5 million acres contained *some level* of current-year faders [trees killed the previous year]. In preceding, and subsequent years, many of those same acres also contained "current-year" faders as MPB outbreaks built, then declined, in a local area. We estimate the total number of acres infested, to some degree, over the last 25 years as nearly 3 million.) Since 1981, there has been a gradual, but steady decline in extent of the infested area. In 1991, an estimated 163,300 acres contained trees killed by MPB during 1990 (Oakes and Gibson 1992).

A combination of aerial survey and ground-collected data suggest more than 3 million acres, in the Northern Region, have been infested during the past 25 years. A conservative estimate indicates an average 80 trees per acre have been killed. Of those nearly quarter-billion trees, in excess of 90 percent were lodgepole pine (Unpublished office reports).

## *Management Strategies*

Until approximately the mid-1970's, pest managers somewhat naively believed that MPB-killed trees were the manifestation of a pest problem--and that the solution to the problem was simply one of removing the pest. Attempts at that solution were many and varied--ranging from cutting, piling and burning of infested trees to wide-scale applications of pesticides. Virtually all were unsuccessful (Klein 1978).

Finally, during the mid- to latter part of the 1970's, we realized that the problem was not a plethora of beetles, but a preponderance of susceptible host type. We noted that lodgepole pine stands in which beetle-caused mortality was the greatest shared remarkably similar characteristics. Nearly all were older, densely stocked with large-diameter trees and growing at a combination of elevation and latitude conducive to optimal beetle development. Further, the most devastated stands were those on the best sites--having grown sufficiently well to develop thick phloem (the beetles' food supply), prior to their slowing in growth and becoming susceptible to beetle attack. Recognizing these commonalities was a significant step towards the development of a more feasible means of reducing tree losses to MPB (Amman 1972).

One of the first major accomplishments was the advent of a "hazard-rating" system for unmanaged lodgepole pine stands. Developed by Gene Amman, and others, in 1977; it is still in use today (Amman, et al., 1977). That system has enabled us to identify those stands most likely to support MPB outbreaks as: stands in which the average diameter is greater than 8 inches; age exceeds 80 years; and which are growing at lower elevations and more southerly latitudes. Unfortunately, that recognition also led to the realization that--as a result of effective fire control over the past several decades and the "unmanaged" condition of most lodgepole pine stands--there were literally tens of millions of acres of susceptible stands in the western United States and Canada. We essentially knew, then, that lodgepole pine mortality caused by MPB would be significant--and that because the beetles could move through stands more rapidly than we could--even our best efforts would do little to "stem the tide."

Still, a knowledge of which stands were exposed to the greatest risk enabled us to concentrate what efforts were expended in the areas of highest priority. Our first "silvicultural" recommendations were basically the identification and removal of high-hazard stands. To the extent we could identify a highly susceptible stand, and remove it prior to its being infested, we could accomplish at least two worthwhile objectives: we would not only realize a better return on our investment by selling the timber at a "green" rate rather than a "dead" one; but, more importantly, we reduced the food supply of the beetle. The latter would have been more effective had we been capable of moving more rapidly than we did; but undoubtedly there was a net benefit in at least some local areas.

Even though our ability to remove high-hazard stands was limited, the combination of stands regenerated and those killed by the beetle--which were salvaged as often as could be practicably done--resulted in overcutting in some areas. In a number of the most seriously affected drainages, other resource values were being threatened. That provided the impetus for exploring other silvicultural opportunities. Some of the first researched were "diameter-limit" cuts, in which the largest trees in the stand were removed. Those treatments often left stands of questionable quality and were subsequently replaced by "basal area reduction" cuts. Impressive results were obtained with initial treatments. In several replicated studies, uncut "control" stands experienced beetle-caused mortality exceeding 90 percent of the trees over 5 inches in diameter. Nearby treated stands, subjected to similar MPB pressure, showed average mortality rates of 38 percent for the 120 BA cuts, and less than 10 percent for the 100 and 80 BA thinnings (McGregor, et al., 1987).

Those studies, installed in 1978/79 and monitored for the last time in 1985, on the Kootenai and Lolo NFs, provided a broader range of alternatives for MPB-threatened lodgepole pine stands. They ultimately led to the development of guidelines for selecting stands in which such treatments might be most successful. These guidelines have become an important part of our recommendations to the land manager for lodgepole pine stands subject to MPB attack (Bollenbacher and Gibson 1986).

Beginning in 1984, the availability of semiochemicals for MPB provided a tool which has the potential for making silvicultural treatments even more effective. Aggregative pheromones have shown the ability to effectively concentrate beetles into stands scheduled for removal (Borden, et al., 1983). Antiaggregative ones, while still being evaluated, may eventually provide a means for protecting high-value stands (Gibson, et al., 1991).

To date, management recommendations for MPB address stand conditions rather than beetle depredations, per se. We still recommend "hazard rating" of host stands. In that way, management activities may be directed, in a preventive strategy, towards stands of greatest susceptibility. Stands adjudged to be high hazard are further subjected to analysis using a "rate of loss" model which fairly accurately predicts the amount of mortality expected in a lodgepole pine stand of certain characteristics, over a 10-year infestation period (Cole and McGregor 1983). It has been extremely useful in directing silvicultural treatments to those stands in which losses are expected to be greatest. Once stand hazard and anticipated loss (risk) have been assessed, we recommend

analyzing the best alternative for that stand(s) in the larger context of its associated drainage, landscape, or ecosystem. Ultimately, the best mix of treatments will be those which create a mosaic of age and size classes and combination of species best suited to sites in the analysis area. The final objective is to create, or maintain, a healthy forest ecosystem--not entirely devoid of pests--but one in which pest-caused mortality is balanced in such a way that no derived amenities of the system are threatened (McGregor and Cole 1985).

*Past Suppression Efforts*

Emphasizing, as we have, the need for preventive rather than suppressive actions for most bark beetle-related management programs, we have encouraged the hazard rating of all stands for which those systems are available. Because additional costs have been incurred in collecting the data necessary to hazard rate stands and implementing the recommended silvicultural treatments in a timely manner, Forest personnel have requested supplemental funding. Because the only funding source available at the time was yearly suppression funds, we requested and received funds for these largely "preventive" activities. Forest Pest Management suppression funds only supplemented other appropriated timber mangagement dollars to accomplish these projects.

For the purpose of this report, rather than analyze the efforts of each Forest which has received suppression funding relative to MPB, I have chosen to look at the expenditures and accomplishments of but three Forests. These three, the Flathead, Kootenai and Lolo, are not only representative of MPB-related activities, but during the decade of the 1980's were the most severely affected Forests in the Region. The analysis period is the 10 years from 1982 through 1991.

Table 1 illustrates the effect of the beetle on the Flathead, Kootenai and Lolo NFs for the analysis period. Total acres affected in the Region are included as a comparison.

Table 1.--MPB-Affected Acres on the Flathead, Kootenai and Lolo NFs
1982-1991
(Derived from aerial survey data)

| Year | Flathead | Kootenai | Lolo | Region |
|---|---|---|---|---|
| 1982 | 91,281 | 170,163 | 18,558 | 2,174,651 |
| 1983 | 153,791 | 105,465 | 43,676 | 1,537,156 |
| 1984 | 185,959 | 608,422 | 42,450 | 1,333,633 |
| 1985 | 424,221 | 577,439 | 33,269 | 954,445 |
| 1986 | 283,635 | 423,173 | 52,990 | 885,592 |
| 1987 | 246,533 | 321,537 | 47,988 | 721,586 |
| 1988 | 108,754 | 347,558 | 39,377 | 558,414 |
| 1989 | 62,978 | 278,955 | 36,534 | 436,587 |
| 1990 | 11,523 | 145,567 | 26,393 | 199,615 |
| 1991 | 13,801 | 108,796 | 28,217 | 163,269 |

Table 2 shows results of suppression dollar expenditures, by Forest for the same period. Shown are both acres harvested and hazard rated. Both activities were at least in part supported by suppression funds.

Table 2.--Acres Harvested and Hazard Rated in Response to MPB
Flathead, Kootenai and Lolo NFs
(1982-1991)

| | | ----Acres Hazard Rated*---- | | |
|---|---|---|---|---|
| Forest | Acres Harvested | High | Moderate | Low |
| Flathead | 27,544 | 145,000 | 55,000 | 8,000 |
| Kootenai | 188,000 | 126,800 | 28,900 | 69,500 |
| Lolo | 28,400 | 103,000 | 99,000 | 17,500 |

* Some areas on each Forest were rated prior to 1982

Finally, Table 3 lists suppression funds granted and acres treated by Forest, by year, for the analysis period.

Table 3.--Suppression Funds Allocated and Acres Treated*
Flathead, Kootenai and Lolo NFs
(1982-1991)

| Year | Flathead | | Kootenai | | Lolo | |
|---|---|---|---|---|---|---|
| | *Dollars* | *Acres* | *Dollars* | *Acres* | *Dollars* | *Acres* |
| 1982 | 293,786 | 24,600 | 178,602 | 39,800 | 406,804 | 65,490 |
| 1983 | 267,927 | 14,700 | 186,225 | 43,200 | 112,000 | 55,400 |
| 1984 | 310,779 | 32,600 | 122,657 | 31,800 | 164,127 | 30,100 |
| 1985 | 214,000 | 3,000 | 170,000 | 25,600 | 208,600 | 18,500 |
| 1986 | 104,900 | 10,760 | 37,500 | 23,200 | 90,000 | 482,100 |
| 1987 | 194,655 | 12,000 | 86,457 | 22,895 | 200,642 | 30,081 |
| 1988 | 100,000 | 13,228 | 50,000 | 14,052 | 100,000 | 30,082 |
| 1989 | 163,100 | ----- | 41,200 | ----- | 196,000 | ----- |
| 1990 | 95,580 | 22,620 | 60,280 | 15,000 | 214,200 | 18,300 |
| 1991 | 83,248 | 22,215 | 96,552 | 64,415 | 139,214 | 9,200 |

* Acres "treated" include accelerated harvests, salvage logging or stand exams leading to hazard rating. Aggregating pheromones (tree baits) were used in conjunction with some of this harvesting.

*Discussion*

The preceding data show that in the past decade, more than 650,000 acres of lodgepole pine type, on those three Forests, have been hazard rated as a result of threats from MPB. Approximately 350,000 were rated "high hazard." Slightly less than 244,000 acres have been harvested from those Forests in the past decade. Some of that total has been salvage logged--harvested after having been attacked by the beetle; the remainder was harvested in an effort to reduce stand hazard. Precise figures on the amount of "high-hazard" stands remaining, as MPB infestations continue a decade-long decline, are not available. Certainly, many of those harvested were from the acres of high-hazard stands. Other of those acres have experienced MPB depredations, but were not salvage logged. It has been estimated that about 20 percent of the lodgepole pine stands rated "high hazard" on the Flathead NF have not been harvested. Most of the trees in those stands are now dead, but were never cut because of various resource considerations (J. VanDenburg, personal communication).

We likewise have no definitive way of determining the amount of "moderate hazard" stands which did not experience MPB outbreaks because adjacent high hazard stands were harvested prior to being infested. Personal observations indicate the amount would be considerable. Trees less than about 6 inches in diameter are rarely attacked successfully, except during extreme epidemics when small-diameter, healthy trees may be overwhelmed by sheer numbers of beetles. When small--moderate- to low-hazard--trees are attacked, few adult beetles emerge, but the trees are killed, nonetheless. The same applies to stands. It is likely, therefore, that many of the nearly 183,000 acres of moderate-hazard stands would have experienced significant amounts of beetle-caused mortality had the numerous acres of high-hazard stands not been removed.

A legitimate question is: What have we accomplished in the past decade with the "suppression funds" expended in the name of reducing losses to MPB? Unfortunately, we don't have a very firm answer. On just the three Forests which are a part of this analysis, well over 1 million acres have been affected to some extent. Using a very conservative estimate of 30 trees per acre killed during that time (aerial survey estimates--supported by ground surveys--consistently indicate an average of 3-4 trees per acre killed per year over the total infested area), we can assume at least 30 million trees have been killed. Total acres harvested were 244,000. Another somewhat conservative estimate of 150 trees per acre is assumed. Approximately 80 percent of the trees cut were green--but threatened (J. Park, personal communication). That represents another 29.3 million trees. Without data to support my supposition, we believe it safe to assume that had the harvesting which was done, not been done, total beetle-killed lodgepole pine would have been about twice what it was during the past 10 years. And that just on the Flathead, Kootenai and Lolo NFs.

Until only recently, lodgepole pine timber value had been fairly consistent at around $40 per MBF for green volume; $2 per MBF for dead. At a reasonable estimate of 50 BF per tree ("average" for a 9-inch lodgepole pine), 29.3 million trees represent approximately 1,500 MMBF. Stumpage at the "green rate" would be worth approximately $60,000,000; at the "dead rate" $3,000,000--a difference of $57,000,000. That would represent the amount of income foregone had the trees not been cut until after they were killed. Had they not been salvaged, as some beetle-killed trees were not, that difference would have been even greater.

For illustrative purposes, we'll assume the trees which were cut were sold at the "green rate," and that a total revenue of $60,000,000 was realized (this analysis does not address the "costs" associated with administering a timber sale, and so does not consider the issue of profit or loss on individual sales). From the data presented in Table 3., we note approximately $5,000,000 of FPM suppression funds were expended during the period, on the three Forests. It is a safe assumption that many of those trees would have been harvested in the absence of FPM funds--perhaps more than half (V. Applegate, personal communication). If, however, only 25 percent of them were harvested because FPM funds were available, that still represents a $15,000,000 return on a $5,000,000 investment over a 10-year period. At a reasonably conservative return rate of 4 percent, a benefit/cost ratio of 1.74 was realized--a pretty good investment by any standard of measure.

If these analyses are accurate, and we believe if anything, they are conservative; it appears those suppression funds were judiciously spent.

## *Conclusion*

Because we believe the state of our knowledge regarding management of lodgepole pine stands to reduce losses to MPB is, if not perfected, sufficient to prevent large-scale mortality; we envision only minor modifications in our methods in the future. Certainly the refinement of "hazard-rating" systems to better define stand susceptibility; and the development of more accurate computer models to describe "stand risk" (potential beetle-caused mortality) will enable us to more adequately prioritize stands for preventive treatments. Though there may be times when truly "suppressive" activities are warranted, the greatest long-term benefit will almost always be realized through the prevention of MPB outbreaks by silviculturally altering stand susceptibility.

Perhaps nowhere is the time-honored adage "an ounce of prevention is worth a pound of cure" more appropriate than in host stand management to prevent losses to bark beetles. That being the case, there will always be a need for the expenditure of funds in a purely "preventive" mode--at least as we attempt to keep bark beetle-caused mortality within acceptable limits.

Though MPB populations are currently still declining in the Northern Region, we have hundreds of thousands of acres of lodgepole pine which will grow into size and age classes susceptible to MPB within the next couple of decades. We believe this analysis has shown the benefit of hazard and risk rating, and stand alteration prior to beetle outbreaks, as a means of significantly reducing potential losses to MPB. Further, we would hope that the lessons of the past--as we move into an era of "new perspectives"--would make future treatments even more timely, efficient and effective.

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